

ONR D&I Electronics Technology Programs Report

Contract Number: N00014-06-C-0054

Performer: HRL Laboratories

Contract PI: Jeong Moon

Program Period (Baseline): 2/23/06 – 12/31/08

Reporting Period: Sep, 2008

Program Status:

One of the D&I program goals is to develop greatly improved field-plated MMW GaN HEMT devices with high f_t/f_{max} , which will improve gain/PAE and output power of GaN HEMT MMIC PAs simultaneously. The 6-wafer MMW GaN MMIC lot is competed with the front-side processing and waiting for the back-side processing.

Key Accomplishments or milestones:

- 1) Figure 1 shows optical photographs of MMW GaN MMIC circuits in the fab currently.

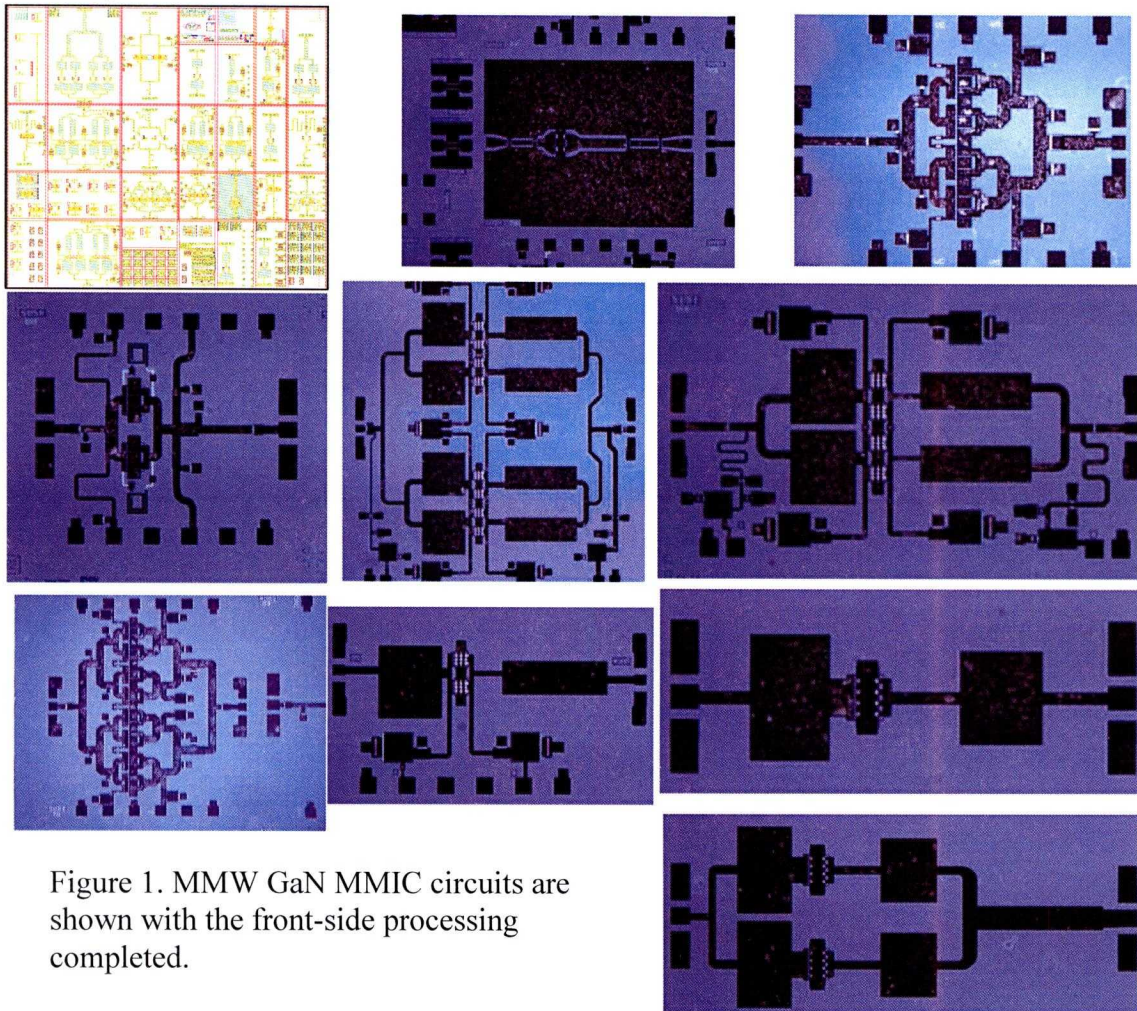


Figure 1. MMW GaN MMIC circuits are shown with the front-side processing completed.

All the PCM devices are tested and characterized in terms of DC and RF. Table 1 shows measured $2 \times 100 \mu\text{m}$ PCM devices after the front-side processing complete, in

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comparison to those from the EEHEMT device model used for MMW GaN MMIC circuits.

Table1: Summary of GaN37 wafers in processing

Wafer	Idss/Imax (A/mm)	I _{min} (mA/mm) @ V _{gs} = - 6V	Peak gm (mS/mm)	V _{po} (V)	F _t (GHz)	Status
Design Target	0.78/1.01	<0.0001*	377	-2.9	55	EEHEMT model
G544	1.01/1.16	1.2	325	-3.88	50	Backside processing
G552	--	-	-	-	-	Broken
G632	0.8/1.0	0.25	366	-2.4	52	Backside processing
G634	0.85/1.08	0.2	414	-2.3	55	Backside processing
G645	0.86/1.07	0.1	391	-2.5	54	Backside processing
G646	0.91/1.11	0.1	385	-2.7	53	Backside processing

- I_{max} is defined at V_{ds} = 1 V at this time
- I_{min} was measured at V_{ds} = 10 V and V_{gs} = -6 V, well below the V_{pinchoff}.
- F_t was measured at V_{ds}=10 V and V_{gs} at peak gm.
- *The EEHEMT model is not well established below the pinch-off voltage.

- 2) Single-stage CPW circuits are characterized in terms of gain and bandwidth, and compared with the simulation. Figure 2 shows the comparison plot. The bandwidth is wider than that of simulated. It is attributed to a change in the input match. With the backside processing complete, we will have more results to compare with.

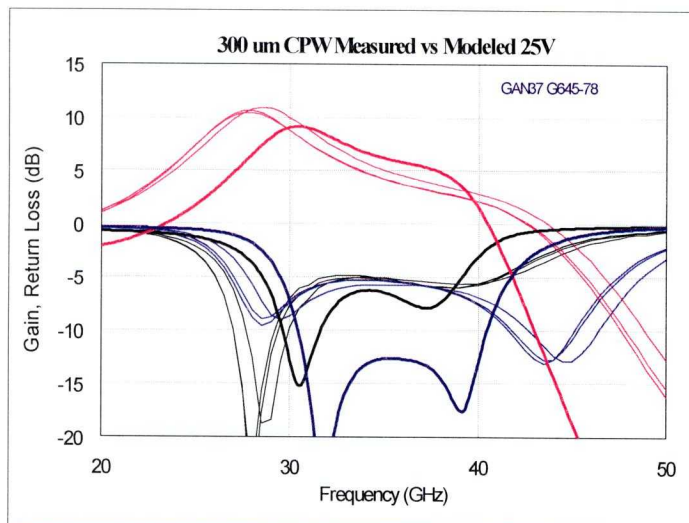


Figure 2. Measured (thin lines) and simulated (thick lines) s-parameters of the single-stage CPW MMICs are shown with 25 V_{ds} and 200 mA/mm. The gain and bandwidth are not sensitive to V_{ds} over V_{ds} = 20 – 28 V, and I_{ds} = 200 -70 mA/mm.

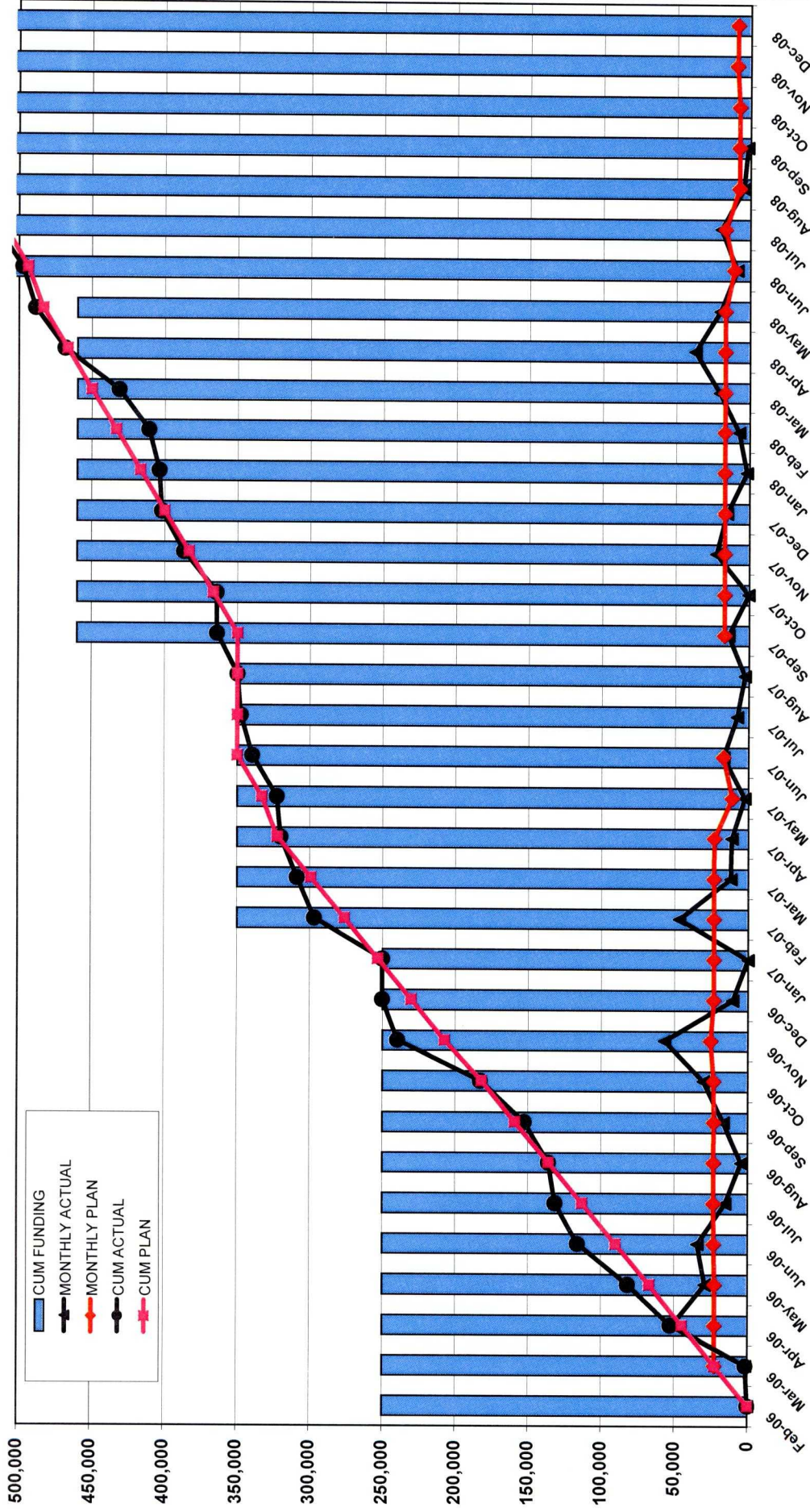
Objectives for next month:

- 1) Complete the MMW GaN MMIC lot.

Budget summary: The available funding to be spent would be ~\$60 K with a fee in the contract, which has a total funded amount of \$ 550 K.

Prog Mgr J. Moon	Award: 549,945	Funding: 549,945	Expenditures: 522,764	Balance: 27,181
Contract No N00014-06-C-0054	Reporting Period From: 9/1/08	Thru: 9/26/08		
Contract Type: CPFF	HRL PROPRIETARY			
Report Description: FUNDS EXPENDITURE GRAPH				

BC57 - GaN HEMTs for Simultaneous High Power and High PAE MMW Operation



[illegible]

Dollars**HRL PROPRIETARY**

MONTH	Feb-06	Mar-06	Apr-06	May-06	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07	Apr-07	May-07
MONTHLY PLAN	-	22,315	22,356	22,333	22,977	23,001	23,061	22,924	23,038	25,183	23,014	22,983	23,024	23,019	22,956	10,808
CUM PLAN	-	22,315	44,671	67,004	89,981	112,982	136,043	158,967	182,005	207,188	230,202	253,185	276,209	299,228	322,184	332,992
MONTHLY ACTU	-	1,432	51,215	29,132	34,270	15,422	4,525	16,603	30,176	56,791	10,489	-	46,797	11,952	11,251	2,474
CUM ACTUAL	-	1,432	52,647	81,779	116,049	131,471	135,996	152,599	182,775	239,566	250,055	250,055	296,852	308,804	320,055	322,529
CUM FUNDING	249,963	249,963	249,963	249,963	249,963	249,963	249,963	249,963	249,963	249,963	249,963	249,963	349,963	349,963	349,963	349,963

Hours

MONTH	Feb-06	Mar-06	Apr-06	May-06	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07	Apr-07	May-07
MONTHLY PLAN	0	120	121	120	120	120	121	120	121	120	120	120	120	120	120	61
CUM PLAN	0	120	241	361	481	601	722	842	963	1083	1203	1323	1443	1563	1683	1744
MONTHLY ACTU	0	8	134	169	179	35	26	98	160	312	51	101	111	71	62	8
CUM ACTUAL	0	8	142	311	490	525	551	649	809	1121	1172	1273	1384	1455	1517	1525